PREFERENCES FOR WALKING-TO-SCHOOL ENVIRONMENTS: EXPLORING LANDSCAPE DESIGNS THAT ARE MOST WELCOMED BY CHILDREN AND PARENTS

BY

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THESIS

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ABSTRACT

The impact of the built environment on how children and parents make decisions about walking to school has attracted the attention of designers, planners, and policymakers. Yet we know little about the impact of the micro-scale environment of the sidewalk on these decisions about walking to school. This lack of knowledge may lead to a lack of infrastructure investment that would support walkable neighborhoods. This study examines a variety of characteristics in the micro-scale environment and the reactions of parents and students to these characteristics as they think about walking to school. 976 participants were recruited online, at an urban park, and at a museum, and were asked to evaluate simulated sidewalk images. Participants most preferred images that included large trees along sidewalks, as well as settings that included sidewalks far from the street rather than close to the street. Children expressed a slightly greater preference for settings with trees along the street and for the attractiveness of the setting, as compared to adults. The contributions of these findings are discussed in relation to a variety of efforts to create walkable communities.

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CHAPTER 1. INTRODUCTION

A decline in children’s physical activity has drawn the attention of design researchers to the impact of the built environment on children’s preferences. For many children across the world, physical activity is not enough to guarantee their health. Only 24% of children in the United States and no more than 20% of children globally get 60 minutes of moderate to vigorous daily physical activity (PA), as recommended by the World Health Organization (WHO) (Hallal et al., 2012; Katzmarzyk et al., 2018). The negative consequences of too little physical activity on the health and well-being of children are profound and long-lasting (Stark, Meschik, Singleton, & Schützhofer, 2018). The existing research has shown that physical activity is vital to children’s growth and will further benefit them in older age (Janssen & LeBlanc, 2010). Studies have found that the built environment has an impact on children's physical activity (Davison & Lawson, 2006). Those studies encouraged designers to determine the characteristics of the built environment that children prefer and that could lead to an increase in physical activity.

Researchers from multiple disciplines have demonstrated that active transportation is also affected by the built environment. Active transportation to school (ATS) includes walking or biking to or from school and is an effective, flexible, and low-cost approach that increases children’s physical activity (Humbert et al., 2006; Martin, Kelly, Boyle, Corlett, & Reilly, 2016; Pabayo et al., 2012). Importantly, characteristics of the built environment impact children’s choice of active transportation (Pont, Ziviani, Wadley, Bennett, & Abbott, 2009). However, existing studies of the built environment and use of active transportation to school have mostly examined the characteristics of the macro-scale environment (connectivity, land-use mix, etc.); micro-scale characteristics still need more research.

One study, in particular, has shed light on the micro-scale environment and its impact on cycling to school, indicating that, in the views of children and parents, the most important characteristic that encourages cycling is that the bicycle path be separate from motorized traffic (Ghekiere et al., 2015). That study also found that participants preferred having a curb or hedge in between the path and traffic, though the study excluded walking and only focused on the characteristics that impacted cycling. However, among the active travel modes, children often walk (Buliung, Mitra, & Faulkner, 2009; McDonald, 2007). Furthermore, as a daily activity, walking to school contributes more to children's physical, psychological, and social well-being, as compared to cycling (Stark et al., 2018; Webb Jamme, Bahl, & Banerjee, 2018). We do not know the impact of the micro-scale environment—such as the existence of trees along the street or the distance between the sidewalk and the street—and their effect on choices about walking to school. Thus, we still need research about the micro-scale built environment and its influence on walking choices.

This study used photo simulations to test the preference levels of both parents and children for several micro-scale factors, such as street trees, the distance between the sidewalk and the street, shrubs as physical barriers between the sidewalk and the street, and the existence of bioswale. The findings could guide designers to implement solutions that would encourage children to walk to school. This thesis begins by examining the theory and evidence that suggests using a photo simulation survey to do preference research, reports the results, and concludes by discussing the implications for a variety of groups. Enabling and encouraging children to engage in active transportation for daily activities when they are young may be beneficial over the long term, meeting urban planning and public health goals oriented toward the production of active, healthy, and sustainable lifestyles.

1.1. Background

Experts in health fields have been working on how to increase the physical activity of children. Among the various possibilities, active transportation to school has been shown to be an effective way to increase physical activity. At the same time, the impact of the built environment on physical activity has also garnered the attention of policymakers, planners, and urban designers. Thus, in the past two decades, researchers in these fields have studied how the built environment impacts active transportation to school.

1.1.1. Active transportation to school (ATS)

ATS (walking or cycling to school, within a neighborhood) is an important form of physical activity. However, in many countries, the use of ATS has declined considerably over the last few decades (Larouche, 2018). In China, motorized transportation to school increased from 4.2% to 37% from 1997 to 2011 (Yang, Hong, Gurney, & Wang, 2017). In the United States, the active transportation rate among children decreased from 47.7% to 12.7% between 1969 and 2009 (McDonald, Brown, Marchetti, & Pedroso, 2011).

Some researchers have tried to explain these declines. In the United States, land use patterns have changed, with public facilities becoming more scattered as urban areas have sprawled, and the average distance between home and school has increased in the past fifty years, as schools are increasingly built on the fringes of communities (Frumkin, 2002). The distance between home and school is a substantial factor that contributes to a decline in children's use of active travel modes (Rothman, Macpherson, Ross, & Buliung, 2018). In addition, as a consequence of suburbanization, the population density surrounding schools has decreased, and this lower population density is associated with lower walking rates (Ewing, Schroeer, & Greene, 2007; Frank, Schmid, Sallis, Chapman, & Saelens, 2005; Napier, Brown, Werner, & Gallimore, 2011). However, research appears to show that walking rates even within closer distances are still lower than they once was (C. Lee, Zhu, Yoon, & Varni, 2013). Thus, the challenge remains how to encourage children to choose walking as their preferred travel mode.

The Safe Routes to School (SRTS) program provided some effective standards. SRTS originated in Denmark, later reaching the United States, and has successfully increased children's walking rate in multiple states (McDonald et al., 2014; O. Stewart, Moudon, & Claybrooke, 2014). SRTS involves education awareness and engineering engagement (O. T. Stewart, 2018). According to its principles, designers should emphasize the improvement of infrastructure at the street level, focusing on sidewalks, multiuse paths, traffic-calming devices, traffic signals, and pedestrian and bicycle crossing improvements. Quicker, lower-cost solutions include landscaping maintenance, altering the timing of traffic lights, painting crosswalks, or installing stop signs (Timperio, Veitch, & Sahlqvist, 2018).

1.1.2. Built environment and active transportation to school

In the past two decades, several interdisciplinary researchers have focused on built environments and physical activity. An ecological model (Figure 1) has been the guiding theory behind most of this research. Using this ecological model theory to achieve positive changes in human behavior requires interventions at multiple levels, including at the individual, environmental, and policy levels (Sallis & Owen, 2015).

Children's active transportation is a kind of physical activity and thus determined by multiple levels of influence, which be explained by this ecological model. Although individual and social factors affect active behavior (Bauman et al., 2012; Sallis et al., 2006), the built environment matters for its potential sustained impact on a population (Brownson, Hoehner, Day, Forsyth, & Sallis, 2009; Ding, Sallis, Kerr, Lee, & Rosenberg, 2011; Giles-Corti, Timperio, Bull, & Pikora, 2005; Sugiyama, Leslie, Giles-Corti, & Owen, 2009).

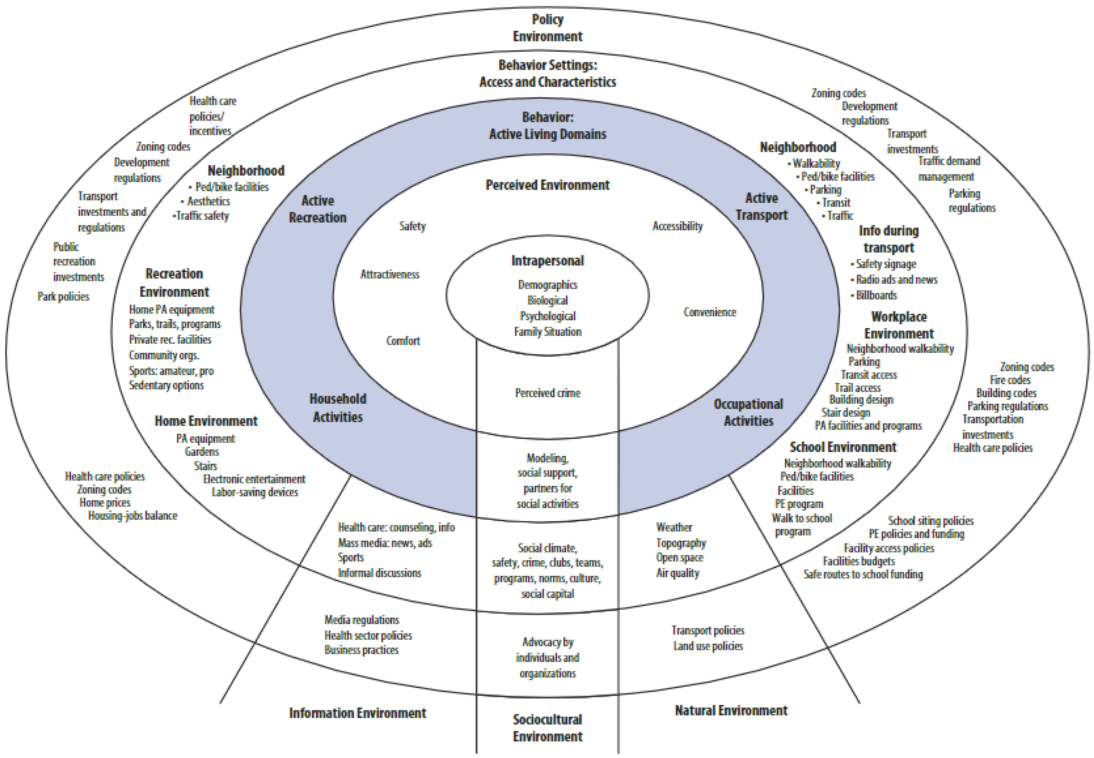

Figure 1: Ecological model of four domains of active living (Sallis et al., 2006).

The built environment includes human-made features such as land-use patterns, transportation systems, aesthetics, streetscapes, buildings, infrastructure, and other smaller design features, such as lighting (Giles-Corti & Donovan, 2002; National Research Council, 2005). We can also categorize them into macro-scale and micro-scale, or human-scale, features. Macro-scale features include density, the connectivity of streets, and land-use patterns; micro-scale features, involving street-level design and aesthetics, correspond to human walking speed, including trees along the street, separation from traffic, or other aesthetic features (Brownson et al., 2009; Ewing, Handy, Brownson, Clemente, & Winston, 2016; Sallis et al., 2011).

From a review of the previous literature, most research on the built environment and walking to school centers on macro-scale factors and their impact. Residential density and land-use mix largely correlate with the physical activity of adolescents (Ding et al., 2011). In addition, residential density, distance to non-residential destinations and the land-use mix is related to walking or walkability level (Frank et al., 2006; G.R. & A., 2011; C. Lee & Moudon, 2006, 2008; Saelens & Handy, 2008; Van Holle et al., 2012). Further research has indicated higher walkability is associated with higher rates of the active transportation of children to school (D'Haese et al., 2015).

More recent research has paid attention to micro-scale factors. Compared to the macro-scale, these human-scale factors like streetscape, aesthetics, and building façades are more directly tied to human perception. Thus, people's preferences vary with respect to different micro-scale environments, such as whether trees are planted or where they are located. For example, recent research has shown that having trees between the a cycle lane and the street is preferred by cyclers (Lusk, da Silva Filho, & Dobbert, 2018).

However, most research has focused on the overall population and physical activity, instead of specifically on children's active transportation, which itself is largely affected by their parent's decisions. Though one researcher has examined the relationship of micro-factors with children's active transportation, that study only examined the attitudes of children and parents toward cycling (Ghekiere et al., 2015). Thus, we still lack evidence about micro-factors and their impact on the attitude of children and parents toward walking to school. Specifically, the sidewalk environment is a micro-scale factor that influences children's perception of walking to school, though this has received little attention.

Walking to school is the most common means of ATS in most countries. In the United States, walking is the most typical form of active transportation to school (Larouche, 2018), and in developing countries, walking is the primary mode of transportation to school (Adewale L. Oyeyemi, 2018). However, perceptions of safety are barriers that makes people feel hesitant about walking to school.

Micro-scale environments are visually closer to those who experience them, which may have some effect on perceived safety. Research has indicated that human-scale environmental factors, such as tree density and grass maintenance, enhance the perception of safety (Kuo, Bacaicoa, & Sullivan, 1998). As the sidewalk environment becomes greener, children may enjoy walking to school more.

Moreover, walking creates more direct and longer interactions with one's surroundings, as compared to cycling within the same distance, which will benefit children. Walking to school is associated with a healthier level of physical activity and body weight (Faulkner, Buliung, Flora, & Fusco, 2009; M. C. Lee, Orenstein, & Richardson, 2008; Ozdemir & Yilmaz, 2008). In the long run, walking to school benefits a child's social skills, mental well-being, and cognitive development (Webb Jamme et al., 2018).

Children will also benefit from a greener sidewalk. The consistent exposure to green spaces has been shown to support a child's well-being. Thus, researchers need to learn whether grass and street trees influence a child's choice to walk to school, how they perceive the streetscape, and what they like most and least about the ways the sidewalk's green space was built. The question remains how to measure the attitudes of children and parents toward different micro-scale environments.

Although earlier studies have revealed a promising association between green surroundings and attitudes toward walking, most of these studies have been descriptive, but rely on participants calling up mental images to describe their walking experiences, which may include individual biases. People are more likely to pull up a mental image which may include bias. Thus, building on previous findings, a photo simulation preference is the best way to test which built environments are preferred by children and parents.

1.1.3. Photo simulation

In order to examine the preferences of children and parents preference for various micro-scale environments, a simulated photo questionnaire was used. Previous studies that used photo simulations to study preferences were successful as these simulations can control the variables that appear in the image (Kenwick, Shammin, & Sullivan, 2009; Sullivan, 1994; Sullivan & Lovell, 2006).

Other researchers used Geographic Information System (GIS) data, collecting participants' walking behavior and their home-to-school GIS data to analyze how macro-scale factors, such as connectivity and land-use mix, impacted choices about walking to school. Most of this GIS data did not include micro-scale environmental features. Thus, how these micro-scale features influence walking behavior needs more research. While experiments are the best way to determine the causal effects of factor changes on walking behavior, changes in the environment are expensive and time-consuming, and we certainly cannot randomly assign children to live in one type of landscape design or another. Thus, exploratory research is needed to inform urban planners or other researchers on which factor changes will be most likely to affect preference.

Photographs can overcome these limitations in that they neither require participants to recall an environment nor respond based on their own definition of their neighborhood.

Photographs also allow controlled manipulations of physical environmental factors (e.g. sidewalk width, building façades) to test the potential causal relationships between each environmental factor and the preferences of the participants. Photographs further allow researchers to simulate and test these changes relatively quickly and at a low cost. Although photo simulation has been tested in several pilot studies, only a few of them have investigated active transportation and those were limited to studying cycling. Walking to school has never been studied in this way before.

CHAPTER 2. METHODS

2.1. Development of the photographs

All photographic simulations were made using Adobe Photoshop. The base images were taken in the Champaign, Urbana, and Chicago, Illinois, and from the perspective of a human walking at street level. We picked three suburban and two urban neighborhoods, based on previous research that neighborhood environment characteristics are related to the use of active transportation (Saelens, Sallis, & Frank, 2003). In addition, the built environments around homes have higher impacts on choices about how to travel to school than the built environments around schools (Mitra, Buliung, & Roorda, 2010).

We added 14 different micro-scale features to each base image to simulate walking environments. Those images were modified using the following parameters.

The distance between the sidewalk and the street without trees (Figure 2), at three levels: no distance, a small distance (4 feet), and a large distance (8 feet). This variable allows us to examine the effect of the distance between the sidewalk and street on people's attitude toward walking to school.

Two variables consider the role of vegetation, each at three levels. First, there was a small distance with various types of vegetation of three types (Figure 3): with shrubs, with small trees, and with large trees. Second, there was a large distance with vegetation of three types (Figure 4): with shrubs, with small trees, and with large trees. These two variables allow us to examine people's preferences toward the different sizes of plants. Researcher assumed that different sizes of plants create a different sense of physical barrier against the street.

We also examined a possible future neighborhoods development feature, bioswale, of five types (Figure 5): a grass channel, a grass channel with water, a channel with bioswale ground cover, a grass channel with trees, and a channel with trees and ground cover. Bioswale is an emerging landscape infrastructure type with environmental benefits. This variable allowed us to understand the potential impact of bioswale on the preferences of children and parents toward walking to school.

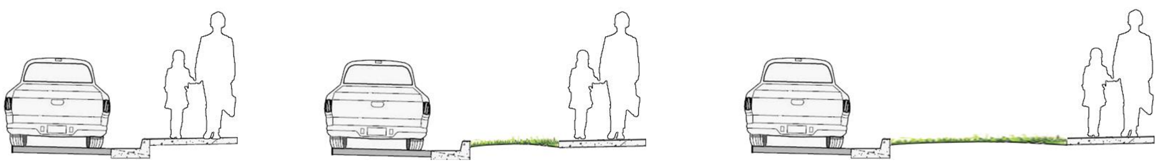

Figure 2: Examples of sidewalks at various distances from the street.

Figure 3: Examples of sidewalks located at a small distance from the street with various types of vegetation.

Figure 4: Examples of sidewalks located at a large distance from the street with various types of vegetation.

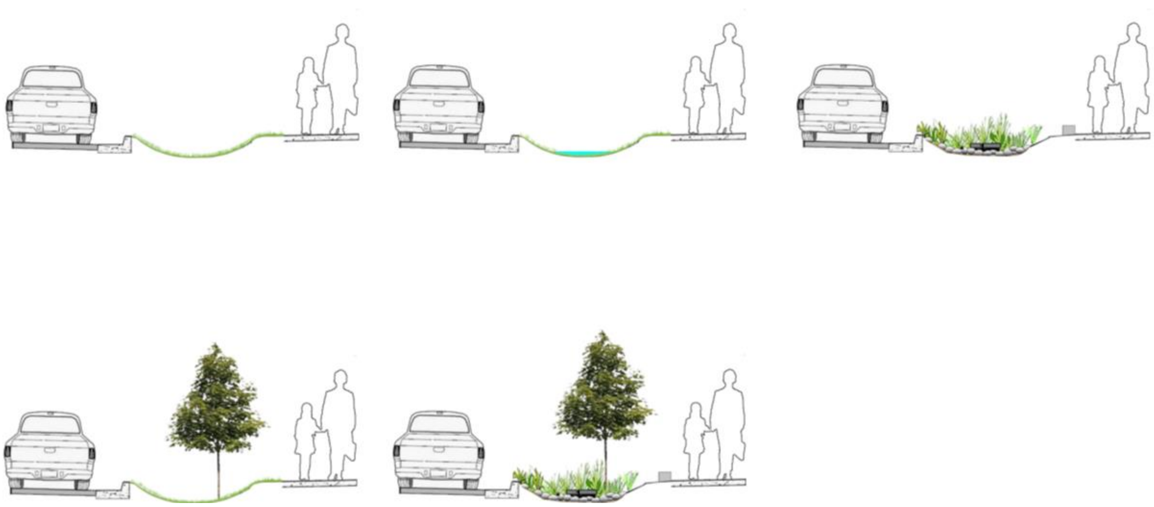

Figure 5: Examples of a bio-swale between the street and sidewalk along with a tree planting with and without understory plantings.

Each of the 14 micro-scale features was added to five different base images, with slight differences in the plant types or appearance, resulting in a total of 70 photo simulation images.

2.2. Recruitment and procedures

In order to record the attitudes of children and parents regarding walking to school in different environments, two questionnaires were developed using the online survey tool Surveygizmo, one for children and one for parents. The questionnaires were deployed in two ways: first at both the Maggie Daley Park and the Field Museum in Chicago, second via Amazon Mturk, collecting information from both child and parent participants in various states. Both methods have strengths and limitations. Participants recruited in the Chicago area are more familiar with the neighborhoods presented in the base images, which were taken in Chicago and suburban Illinois, though this familiarity with the environment might introduce bias. Participants recruited from other states might not be as familiar with these neighborhood environments, so their preferences might depend more on how they imagine the locations.

Online data was collected as follows. When researcher published the questionnaires on Amazon Mturk, The researcher set up selection criteria. Adult participants with access to the questionnaires must have been located in the U.S at the time. and have at least one child between the ages of six and eighteen. Amazon Mturk filtered out unqualified participants. Once participants opened the questionnaire, they signed a consent form, agreeing that they or their children would like to participate.

When we distributed the questionnaire in the public, experimenters set up a poster and table to encourage participation and also directly approached families that appeared to have children in the correct age range to participate in the research. The child and their parent were informed about the objective, procedure, benefits, and risks of participating in this study via a consent letter. When the participant was a child and a parent was present, the parent signed a parental consent letter. If the child was alone, they signed a children's consent letter. Parents were informed that their children could quit at any time while filling out the questionnaire. Once parental or child consent was obtained, the child filled out the questionnaire on an iPad, so their answers were automatically recorded.

The instructions for the questionnaires were as follows, depending on the participants: "You are about to see a set of 15 pictures, and you will be asked to evaluate them according to how much you would like your child [or, if it was a child taking the survey "how much would you like"] to walk to school if the sidewalk environment is similar to the picture." In the second part, we asked, "think about the route between your home and school, if your child [or, you] are going to walk to school, or your child [or, you] are currently walking to school, how much would the following stop you letting your child [or, stops you] walking to school". In the final part, the instruction was "this is the final part, you will need to answer questions about yourself and how your child [or, you] travel to school." All participants had these basic instructions explained to them, with additional information and clarification added for the children. Children who struggled to understand the questions were noted, and their questionnaires were excluded from the analysis.

2.3. Participants

In this study, a total of 976 people from 46 states participated in the survey; 931 participants provided valid data, including 140 children (42 at the park, 51 at the museum, and 47 online) and 791 adults (online). 99 child participants completed the three parts of the survey (completion rate = 70.7%). 500 adults from the pool of adult participants were only asked to complete the image rating task for factor analysis, 455 finished (completion rate = 91%). 336 adults from the pool of adults who claimed they were parents of at least one school-age child completed all three parts of the survey (completion rate = 93.5%).

The data shows more than 70 percent of children do not walk to school. Although distance is a strong predictor of walking between home and school (McDonald et al., 2011;

Murtagh, Dempster, & Murphy, 2016), children who live within easy walking distance (for children who are 11 to 12, one mile) are not walking to school. 45% of children in our study who do not walk to school live within a mile of their school. The average age of children who walk to school at least once per week is 12.12, as compared to the average age of children who do not walk to school, 11.36 (Sig. = 0.022 < 0.05).

17% of participants lived in rural areas, 19% in the rural-suburban fringe, 45% in the suburbs, and 19% in an urban area.

2.4. Measures

Both questionnaires had three parts: preference for a simulated walking environment, evaluation of existing pedestrian landscapes factors that served as barriers to walking to school, and demographic information.

In the first part, each participant looked at 15 sidewalk images randomly selected from the larger group of 70 images. The images were shuffled each time a new questionnaire began. Participants were asked to indicate how would they feel about [or, if the questionnaire was for parents “how would they feel about letting their child”] walking to school if the sidewalk between their home and school were similar to that in the image. The evaluation used a five-point scale (not at all, a little, somewhat, a lot, very much) which participants used to indicate their preferences.

In the second part, participants evaluated how much the current environment between their home and school stopped them from walking to school (or, letting their children walk to school). The evaluation used a five-point scale (not at all, a little, somewhat, a lot, very much). In this section, twelve questions asked about sidewalk conditions, the existence of micro-scale environmental features, and potential dangers.

The last part helped identify whether the effect of micro-scale environmental factors was equal across different groups. Participants answered demographic questions, such as their age, important because as children grow older, the importance of safety might decrease with their increased autonomy (Panter, Jones, & van Sluijs, 2008). We also asked about gender (Timperio, Crawford, Telford, & Salmon, 2004), and location, as the researcher hypothesized that specific micro-scale environmental factors might be important depending on the home location (urban, suburban, rural-suburban fringe, and rural). Further, we asked about transportation behavior (walking to school alone or with others, walking frequency) and asked participants to self-evaluate their levels of activity and health (on a five-point scale: not at all, a little, somewhat, a lot, very much).

We first investigated which micro-scale environmental factors contributed to a preference for walking to school for the total sample of both children and parents. Second, we compared groups which were composed based on participants' background information and travel behavior, and their preferences for micro-scale environmental factors. Finally, we examined how much the sidewalks between home and school impacted the attitudes of both children and parents toward walking to school.

2.5. Analysis

First, we used dimension deduction techniques to identify and understand the main categories associated with a particular set of variables, a method used in previous preference studies (Sullivan, 1994; Suppakittpaisarn, Larsen, & Sullivan, 2019). As Sullivan explains, using factor analysis methods, analysts can identify the main categories associated with a set of selected variables; this approach is distinguished by the assumption that the observed covariance is based on certain potential general categories. This procedure was used via a factor analysis tool in SPSS 25 for Mac. All rules followed the preference study conducted by Sullivan in 1994, including:

(1) remove the absolute value of correlation in factor loadings less than 0.4,

(2) set Eigenvalues greater or equal to 1,

(3) remove items shown in two categories, and

(4) at least two items must meet the previous requirements.

After completing the factor analysis, a new set of variables was created for subsequent analysis. These new variables represented the mean rating of each new category generated by factor analysis for each participant. In the majority of the analyses that follow, these categories are used as the independent variables. At the data analysis stage, analysis of variance was used to test the relationship between independent and dependent variables.

CHAPTER 3. RESULTS

The overall mean score of the 70 images for all participants was 3.3 (on a five-point scale). The means for specific pictures ranged from 2.3 to 4.2. One-way analysis of variance (ANOVA) was used to compare the overall preference mean of children and adults: children's mean = 3.4, adult's mean = 3.5, with a statistically significant difference (Sig = 0.002) between children and adults.

The results are presented in four sections. The first presents the mean scores of each of the six categories generated from factor analysis. Next, the researcher describes the characteristics of the six categories in details. The third section compares the mean scores of different population groups for the six categories. Finally, the researcher explores how much current sidewalk conditions affected the choice of whether to walk to school.

3.1. Mean scores of six categories

Factor analysis generated six distinct categories from the preference data of 455 participants. 11 of the original 70 images had an absolute loadings value greater than 0.40 on two or more of the six categories, thus, they were removed from further analysis. The means for the six categories is shown in Table 1 and Figure 6.

Table 1
Preference for sidewalk environment by categories means and standard deviation, on a scale of 1 = "not at all" to 5 = "very much".

Sidewalk environment	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
				Lower Bound	Upper Bound
Large trees	4.0[a]	1.03	0.02	3.94	4.02
Far from street	3.9[a]	1.01	0.01	3.86	3.92
Urban multi-family housing	3.5[b]	1.18	0.02	3.43	3.49
Bioswale	3.4[b]	1.16	0.01	3.42	3.47
Close to street	3.0[c]	1.33	0.02	3.01	3.08
Urban single-family housing	2.8[d]	1.19	0.01	2.74	2.80

Means followed by the same letter are not significantly different at $p < 0.05$ level.

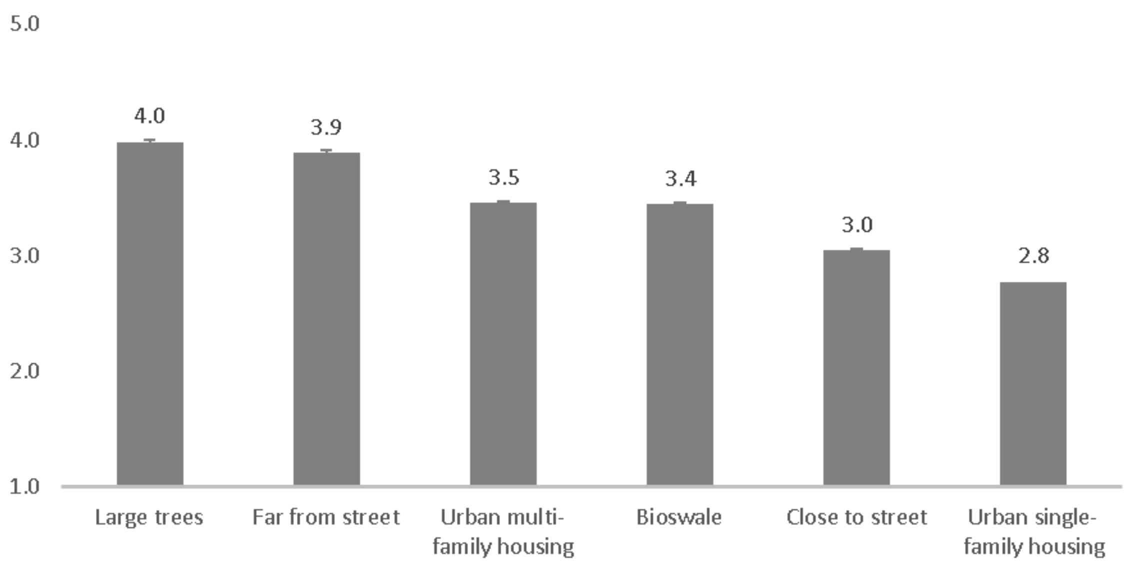

Figure 6: Overall mean preferences for sidewalk environments by category. Preferences were rated on a scale from 1= not at all to 5= very much.

The mean rating for all participants showed that the categories of Large trees and Far from street were most preferred. The Urban single-family housing category was the least preferred.

3.2. Characteristics of photo simulation

3.2.1. Large trees

The Large trees category consists of five images (Figure 7). Each of the images included large trees between the sidewalk and the street, based on images from the suburbs. Three of the images had large trees planted on eight feet of mowed grass between the sidewalk and the street. Two of the images had trees planted on a narrower strip of about four feet of mowed grass of between the sidewalk and the street. Narrow and large distances appeared together in this group because large trees were included. It could be the trees establish a boundary--a visual edge that makes people feel safe with respect to the street. Walking on a sidewalk with such a view would make people feel safer, even when close to the street.

Figure 7: Examples from the Large Tree category. Note that this category includes sidewalks at various distances from the street.

Each scene in this category received a high mean rating of 4.0, with a range between 3.7 and 4.2. The Large tree category was the most preferred of the five categories. The most obvious characteristic of this category is the strong presence of trees. Kaplan and Kaplan demonstrated that trees are a characteristic that is often associated with higher preferences (Kaplan & Kaplan, 1989). The large tree images also include shade. Participants might imagine themselves walking in this setting, surrounded by green and in the shade, and feel comfortable during the summer.

This finding provides evidence that sidewalks with large trees are welcomed by children and parents when making their decisions about walking to school.

3.2.2. Far from street

The Far from street category includes eight images (Figure 8). The neighborhood types in this category were from suburban neighborhoods in Savoy, Champaign, and Urbana, Illinois. Each of the images had a large distance between the sidewalk and the street. Three of the scenes showed only about eight feet of mowed grass between the sidewalk and the street. The remaining images in this category showed plants added in the mowed grass: two images had shrubs and three had small trees.

In this category, the presence of small trees or shrubs on the grass does not seem obviously different than having nothing on the grass. Small trees do not create the same sense of boundary as large trees. Although shrubs are comparable to a physical barrier between the sidewalk and the street, the effect is the same as having only grass. Thus, the researcher infer that distance plays the most important role here.

Figure 8: Examples from the Far from Street category. Note that this category includes various types of vegetation.

The Far from street category was the second most preferred of the six categories. Each scene received a high mean rating, between 3.8 and 4.0. Such a high score might have two explanations. The neighborhoods presented here are well-maintained and quiet. There are no vehicles on the street and the distances between the sidewalk and the street are wide. Walking on these sidewalks, children and parents find themselves safe from traffic. Research has demonstrated that the distance between the sidewalk and street can reduce the fear of being struck by a car. However, this study did not examine differences between a green space between the sidewalk and the street and only pavement when the sidewalk is far from the street. We suggest further research to into this.

3.2.3. Multi-family housing

The Multi-family housing category includes ten images. The neighborhood type in these images was multi-family houses taken in the Chicago area (Figure 9). According to the Chicago Architecture Foundation, the housing type on the left is known as a courtyard building.

Figure 9: Examples from Multi-family housing category.

This category received a mean score of 3.5, ranking it third. The mean scores ranged from 3.3 to 3.7. The environment seems well-maintained and green, which gives people a neat feeling. There are many cars parked on the street, as compared to the neighborhoods taken in Champaign, Urbana, and Savoy. The Multi-family housing category incorporates each of the four variables in this study. It may be that multi-family housing offers a stronger visual impact than other sidewalk environments.

3.2.4. Bioswale

The Bioswale category includes thirteen images (Figure 10). The neighborhood types in this category are typical American suburban neighborhoods. All of them have bioswale between the sidewalk and the street, though the types differ: two feature a channel, three have water in the channel, three have vegetation in the channel, two have only trees in the channel, and three have both small trees and vegetation in the channel.

The mean preferences for this category fall between 3.1 and 3.7. The two highest-rated images, with a mean of 3.7, are images that include trees. The two lowest-rated images, with a mean of 3.1, are images of bioswale with water. In a previous study, researchers provided evidence that people preferred bioswale with trees (Suppakittpaisarn et al., 2019). This category shows that when walking environments having bioswale, the inclusion of trees is preferred by children and parents.

Figure 10: Examples from Bioswale category. Note that the vegetation within this category varies a good deal.

3.2.5. Close to street

The Close to street category involves ten images (Figure 11). The base images are drawn from four types of neighborhoods: three from suburban neighborhoods taken in Savoy, Champaign, and Urbana, and one from an urban single-housing neighborhood taken in the Chicago area. The only difference between this category and the Far from street category is the distance between the sidewalk and the street in each scene, which now has been narrowed to four feet or disappeared. Within the ten images, four have no distance between the sidewalk and the street, while six have a narrow strip of mowed grass. Images having grass included two with small trees and two with shrubs. This category is characterized by a lack of green space between the sidewalk and the street.

Figure 11: Examples from Close to Street category which includes images of the sidewalk immediately next to the street and images of a small separation between sidewalk and street.

The mean preference for this category was nearly a full-scale point lower than the Far from street category and received the second-lowest score. The mean rating is 3.0, with a range of 2.3 to 3.6. When examining the mean for each scene, the four images without any separation between the sidewalk and the street all received mean scores lower than 3, ranging from 2.3 to 2.7. Images with a small distance between the sidewalk and the street received mean ratings between 3.3 and 3.6.

The factor analysis that resulted in these images being clustered together demonstrates that there is no distinction between having the sidewalk next to the street and having it a short distance away from the street. This result is important for landscape architects and urban planners. If the design considers the distance between the sidewalk and the street, it is better to have a larger distance these.

3.2.6. Single-family housing

The Single-family housing category includes thirteen images, based on red-brick single-family homes, taken in the Chicago area (Figure 12). The neighborhood has housing typical of Chicago, with two-flat, three-flat and bungalow-style buildings, found in neighborhoods across the city. This category received the lowest mean score of 2.8. The mean score range is between 2.4 and 3.3.

Figure 12: Examples from Single-family House category. This category is dominated by the presence of red-brick housing. The vegetation in these images varies a great deal.

3.3. Comparison among groups

3.3.1. Comparison between children and parents

Do parents and children differ in their preferences for the six walking environments? The means and standard deviations from one-way ANOVA comparing preference ratings for children and parents are presented in Table 2 and Figure 13. Three significant differences were found.

In the Far from street category, parents indicated a higher preference (mean 3.9) than children (mean 3.4). It is possible that parental concern over children being struck by cars led to the results in this category. Parents also expressed a small but statistically higher preference (mean 3.5) for the Bioswale category than children (mean 3.3). Parents may have more knowledge of the functions of bioswale, including a concern over environmental conditions than children. In the Multi-family housing category, children demonstrated a higher preference (mean 3.7) than parents (mean 3.4). For children, multi-family housing could lead to the possibility of having more friends. Although we found these statistically different responses between parents and children, the magnitude of the difference is small, and there is no consistent pattern visible in the findings relative to these differences.

Table 2
Preferences of children and parents for sidewalk environments by categories means and standard deviations, on a scale of 1 = "not at all" to 5 = "very much".

Walking environment	Mean preference rating				*F*-statistic	*p*-value
	Children N = 77		Parents N = 732			
	Mean	S.D.	Mean	S.D.		
Large trees	4.0[a]	0.9	4.0[a]	0.9	1.4	0.232
Multi-family house	3.6[a]	1.1	3.4[b]	1.0	8.8	0.003
Far from street	3.5[a]	1.0	3.9[b]	0.9	31.6	0.000
Bioswale	3.3[a]	0.9	3.4[b]	1.0	4.3	0.039
Close to street	3.1[a]	1.1	3.0[a]	1.0	0.5	0.483
Urban single-family housing	2.9[a]	0.8	2.8[a]	1.0	1.1	0.298

Means in the same row followed by the same letter are not significantly different at $p < 0.05$

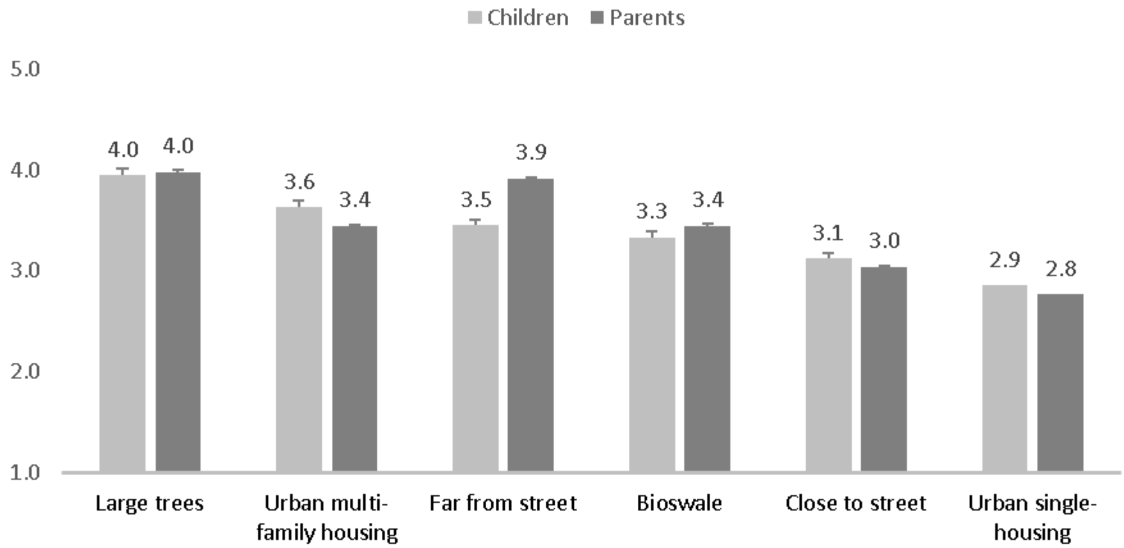

Figure 13: The mean preferences of children and parents for sidewalk environments by category. Preferences were rated on a scale from 1= not at all to 5= very much.

3.3.2. Comparison between children who don't walk to school and those who walk at least once a week

We studied the preferences for children who do not walk to school and those who walk to school at least once a week. Comparing groups who walk and those who do not walk to school, based on children's responses, finding that the difference is not statistically significant. However, children who walk to school show a slightly higher preference toward the Close to street category. A few children participants explained that they wanted a wider sidewalk in order to walk with their friends and that they considered the street to be part of the sidewalk when rating images without distance between the sidewalk and the street (Figure 14). Then we compared these two groups using the parents' responses, we found statistically significant differences. The parents whose children walked to school showed higher preferences for every category.

Figure 14: Examples of no distance between sidewalk and street in the Close to street category.

The researcher wanted to know which factors are most preferred for children who walk to school and which factors are preferred for those who do not walk to school (Table 3, Figure 15). The result would provide guidance for designers to design landscape to encourage both groups of children to walk more. Thus, we did an ANOVA. In the children's responses, we found that for children who do not walk to school, having large trees led to the highest mean score, meaning that if they needed to walk to school, they would prefer large trees along the sidewalk. Close to the street and Urban single-family housing were rated the lowest. For children who walk at least once each week, Large trees and Far from Street are most preferred. Urban single-family housing and Close to the street are the least preferred.

Table 3
Preferences of children, grouped by walking frequency, for sidewalk environments by category, means on a scale of 1 = "not at all" to 5 = "very much".

	Mean preference rating			
	No walk per week N = 56		At least once per week N = 31	
	Mean	S.D.	Mean	S.D.
Large trees	3.9[a]	0.9	3.9[a]	0.8
Multi-family house	3.6[ab]	1.1	3.6[a]	0.8
Far from street	3.4[b]	1.0	3.7[a]	0.9
Bioswale	3.3[b]	0.8	3.4[ab]	0.7
Close to street	2.9[bc]	1.0	3.3[bc]	0.9
Urban single-family housing	2.8[c]	0.8	3.0[b]	0.7

Means in the same column followed by the same letter are not significantly different at $p < 0.05$

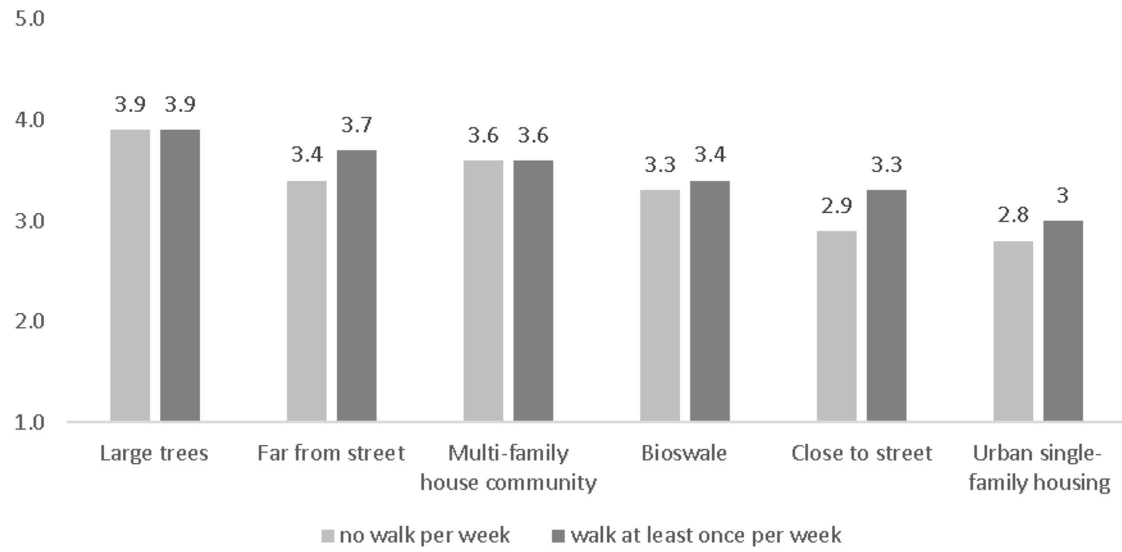

Figure 15: Preferences of children, by walking frequency for sidewalk environments by category, means on a scale from 1 = "not at all" to 5 = "very much".

From the responses of parents (Table 4, Figure 16), for their children who do not walk to school, sidewalks Far from the street and sidewalks having Large trees remain the highest-rated. Urban single-family houses remain the lowest, and Close to the street is the second-lowest. The parents' preference for Bioswale remains moderate. For their children who walk at least once a week to school, Far from street and Large trees consistently remain the highest-rated.

Table 4
Preferences of parents, grouped by children's walking frequency, for sidewalk environments by category, means on a scale of 1 = "not at all" to 5 = "very much".

	Mean preference rating			
	No walk per week N = 206		At least once per week N = 70	
	Mean	S.D.	Mean	S.D.
Large trees	3.9[a]	1.0	4.3[a]	0.8
Far from street	3.9[a]	0.9	4.2[a]	0.8
Bioswale	3.6[b]	1.0	3.8[de]	0.9
Multi-family house	3.2[c]	1.1	3.7[de]	1.1
Close to street	3.3[c]	1.0	3.6[be]	1.0
Urban single-family housing	2.7[d]	1.1	3.3[b]	1.1

Means in the same column followed by the same letter are not significantly different at $p < 0.05$

Figure 16: Preferences of parents, by children's walking frequency, for sidewalk environments by category, means rated on a scale from 1 = "not at all" to 5 = "very much".

3.3.3. Comparison of the distance between home and school

Now the researcher want to understand how preferences correlate to different distances between home and school. In both the responses of children and parents, 335 children do not walk to school and 131 children do. We found around 45% of children who do not walk to school live within a mile from the school (the suggested distance for children between eleven and twelve years old). Thus, we want to determine for children who live within a mile which factors might encourage them to walk to school more in the future. Further, for children who live beyond a mile, might encourage them? We compared children who live a five-minute walk to school and those who live further away, children who live within a ten-minute walk and those who live further away, and children who live within a twenty-minute walk and those who live further away. We found no significant differences between these groups. Then we tried to determine within each category the differences between living within a mile and living beyond a mile away, and again found no differences.

3.3.4. Comparison between living areas

Next, we compared the areas in which children and their parents live. We compared children who lived in rural areas, the rural-suburban fringes, suburban, and urban areas and found no differences between these groups on issues related to preference or safety. We then categorized children who live in rural areas and the rural-suburban fringe into rural areas, and children who live in suburban and urban areas into more urban areas. Again, we found no differences between these two groups. Among parents, only the Urban single-family housing category was rated significantly higher preference for parents who live in rural areas compared those who live in the suburbs.

3.4. Barriers associated with walking to school

In order to determine how much each barrier stops children from walking to school, we asked children and parents to rate the extent to which features of the environment impact their decisions to walk. The mean ratings for all participants are presented in Table 5 and Figure 17. We found that both children and parents care most about safety issues: too many cars, car moving fast, and that the walk feels unsafe. Missing sidewalks are also a safety concern.

Table 5
Factors that stop children from walking to school, means on scale from 1 = "not at all" to 5 = "very much".

Barriers	Mean (N=476)	Std. Deviation
The walking environment is dangerous because cars move fast	3.9a	1.34
The walking environment is dangerous because of too many cars	3.8a	1.34
Missing sidewalks	3.7a	1.47
The walking environment feels unsafe because my children could be watched or attacked	3.5a	1.47
Sidewalks are too close to the street	3.3b	1.45
Poorly maintained sidewalks	3.1b	1.41
Narrow sidewalks	2.9b	1.36
Too many rainy days	2.5c	1.36
The walking environment is unattractive	2.4c	1.31
Too sunny (not enough shade)	2.2c	1.26
The walking environment is unpleasant because it lacks comfortable features (such as benches or bus shelters)	2.2c	1.25
Lack of trees	1.9c	1.14

Means in the same column followed by the same letter are not significantly different at $p < 0.05$

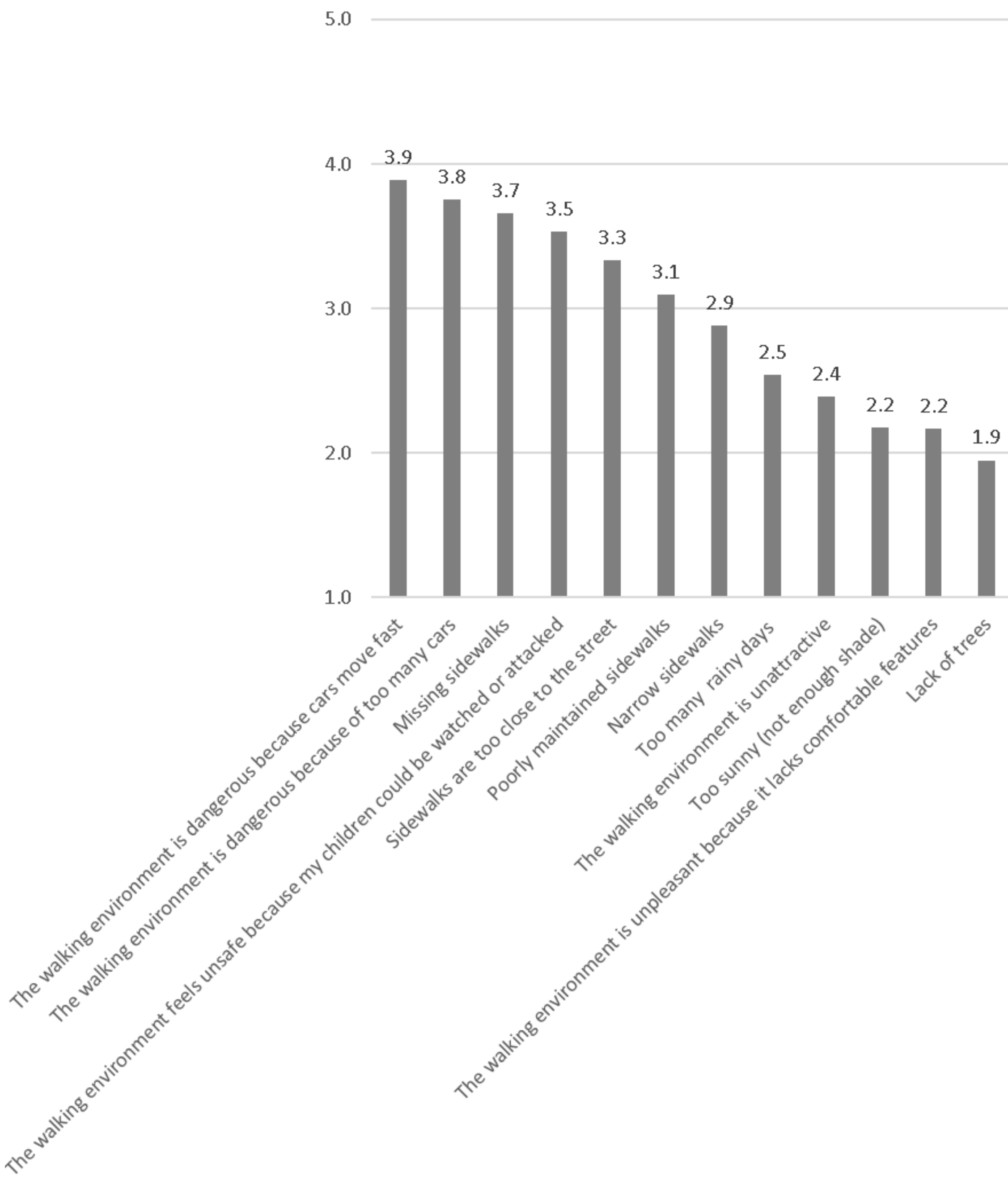

Figure 17: Overall mean scores on how much each barrier discourage walking to school. Preferences were rated on a scale from 1= not at all to 5= very much.

The responses of children and parents toward different barriers in Table 6 and Figure 18 show that children care more than parents about comfort when walking: too many rainy days, the walk is too sunny, the walk is unattractive, and the walk lacks trees. Parents care more about safety issues. Thus, when planning a design that might encourage children to walk to school, besides safety, we should also design the walk to be comfortable and attractive.

Table 6
Factors that stop children from walking to school, comparing the responses of children and adults, means on scale from 1 = "not at all" to 5 = "very much"

Barriers	COMPARISON				*F*-statistic	*p*-value
	Children N = 97		Adult N = 303			
	Mean	S.D.	Mean	S.D.		
The walk is dangerous because cars move fast	3.6[a]	1.5	4.1[b]	1.2	13.1	0.000
The walk feels unsafe because I could be watched or attacked	3.6[a]	1.5	3.6[a]	1.4	0.2	0.661
Missing sidewalks	3.5[a]	1.6	3.9[b]	1.4	5.1	0.024
The walk is dangerous because of too many cars	3.3[a]	1.4	4.1[b]	1.2	25.7	0.000
Sidewalks are too close to the street	3.2[a]	1.4	3.5[a]	1.4	2.9	0.091
Poorly maintained sidewalks	3.2[a]	1.5	3.2[a]	1.4	0.0	0.874
Too many rainy days	3.2[a]	1.3	2.4[b]	1.3	27.8	0.000
Narrow sidewalks	2.9[a]	1.3	3.0[a]	1.4	0.4	0.512
Too sunny (not enough shade)	2.9[a]	1.3	1.9[b]	1.1	47.8	0.000
The walk is unattractive	2.7[a]	1.4	2.3[b]	1.3	5.0	0.026
The walk feels bad because it does not have comfortable things (such as benches or bus shelters)	2.5[a]	1.3	2.1[b]	1.2	7.1	0.008
Lack of trees	2.5[a]	1.3	1.8[b]	1.0	34.7	0.000

Means in the same row followed by the same letter are not significantly different at $p < 0.05$

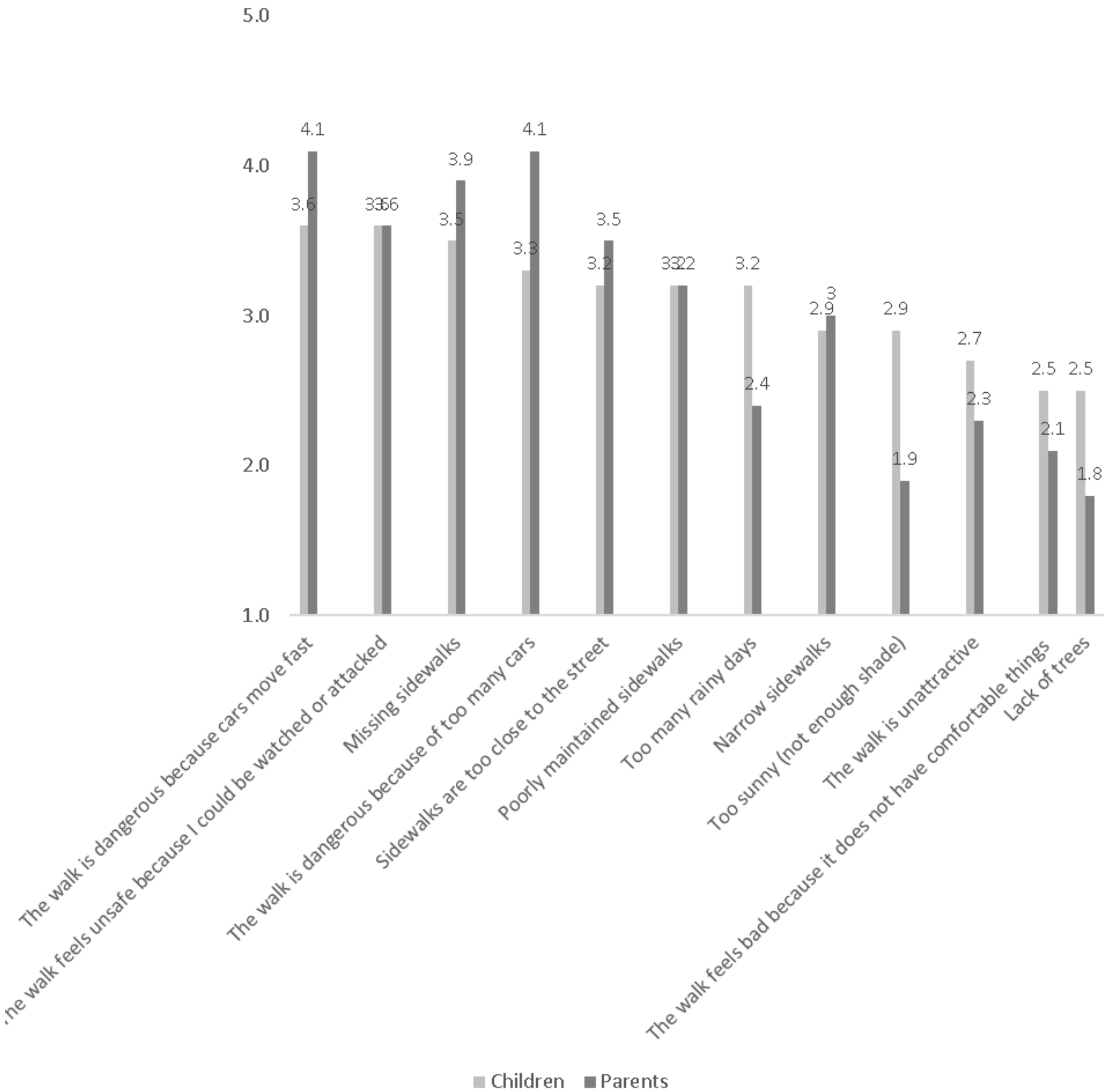

Figure 18: Mean scores of parents and children on how much each barrier discourage walking to school. Preferences were rated on a scale from 1= not at all to 5= very much.

CHAPTER 4. DISCUSSION

This study used photo-simulation to examine the relative preference of human-scale environmental factors which were hypothesized to influence how well a street's design encouraged children to walk to school. Factor analysis identified six unique landscape types about which parents and children expressed quantitative differences. The results show that the attitudes of children and parents toward walking to school are impacted by the human-scale environment. Within these environments, the landscape categories Far from street and Large trees were mostly preferred by both parents and children. Parents seem to care more about safety issues while children care more about the surrounding environment's aesthetics or their comfort levels.

4.1. Contribution

The findings from this study indicate that sidewalks with large trees were preferred by children and parents when walking to school and reinforce the results from a previous study showing that having trees are most preferred when using active transportation to school (Ghekiere et al., 2015). The research findings provide new evidence that sidewalks far from the street are preferred over those close to the street.

The effect of large trees, small trees, and shrubs on creating walkable sidewalks are also different. Large trees are preferred over small trees and shrubs. When large trees exist between the sidewalk and the street, they created a visual barrier that makes people feel safer about the walk to school. These findings add support to a previous study showing that larger vegetation encourages children to walk more (Boldemann et al., 2006). This suggests that policymakers, designers, and planners should include large trees between the sidewalk and the street if the distance between sidewalk and street is narrow.

4.2. Implications

The evidence presented here points to environmental and design factors that designers, planners, and policymakers can use in order to encourage children and parents to use active transportation to school.

Designers need to be careful when dealing with the sidewalk environment, not only ensuring safety but also designing more comfortable and attractive features to encourage children to walk to school. For community leaders, changing the micro-scale factors of the environment will be cheaper and easier to accomplish than focusing on large-scale factors. For example, instead of changing the land-use mix, planting large trees along the sidewalk — even when the distance between sidewalk and street is narrow — will encourage children to walk to school.

4.3. Limitations and future research

The study, like all studies, has limitations. Although we tried to sample a variety of neighborhood types for the photo simulation, the number and types of neighborhoods we showed participants were still limited. We examined a small number of places in which children walk to school: communities in eastern Illinois and Chicago. This relatively small sample of places reduces the generalizability of our findings. In future research, a broader diversity of locations should be examined to determine the extent to which variations in place contributes to variations in the willingness to walk to school.

The micro-scale built environment factors were limited to green features. As landscape designers, green infrastructure features are critically important. Still, other human-made features were not present. In order to make the walk to school comfortable, adding features such as benches may also important. In the future, researchers should add more variety to these micro-scale features.

In addition, this research examined the different views between children and their parents. We were not able to attract many child-parent pairs to participate in the study. Thus, we examined children and parents separately. As a consequence. we were unable to determine the difference between children and their own parents. In a future study, pairs of children and parents could solidify the comparison, because they live together, and thus would have similar lifestyles and behaviors.

CHAPTER 5. CONCLUSION

The micro-scale built environment has some effect on children’s active transportation to school. Thus, by studying the preference of these environments, we can manage landscape design to encourage children to engage in more active transportation to school.

Our study finds that sidewalks far from the street and sidewalks have large trees are preferred by children and parents when walking to school. When a large distance between the sidewalk and street is not available, planting large trees between sidewalk and street could also make people feel safe. Also, comfortable features such as having benches, and attractive features such as trees have an impact on how attractive children report it is to walk to school. Policymakers, designers, and planners who wish to build walkable communities can use these results to create landscapes that encourage children to walk to school more. Children will benefit from such sidewalks and the environment will benefit from more walking and less driving.

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